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AUTHOR Lunneborg, Clifford E.; Lunneborg, Patricia W.
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ABSTRACT

Discriminant function analyses involving two vocational interest inventories (ACT Interest Inventory and Lunneborg's Vocational Interest Inventory) to differentiate majors of college graduates supported the definition of three dimensions: Business Contact vs. Science, Business Detail vs. Arts, and Service vs. Technical. This common structure between groups emerges only under rotation and is consistent with factor analytic results for differences among people. The implementation of such a three dimensional scheme for counseling high school students is illustrated. At the theoretical level these results support the position that the structure of vocational interests is more complicated than postulated by the circular orderings of Roe and Holland or by the appealing bipolar dimensions of Data/Ideas and People/Things. (Author)

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Clifford E. Lunneborg & Patricia W. Lunneborg

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Is There Room for a Third Dimension in Vocational Interest Differentiation?

Clifford E. Lunneborg and Patricia W. Lunneborg

University of Washington

Clifford E. Lunneborg

Associate Professor

Department of Psychology

University of Washington

Seattle, Washington 98195

Running head: Is There Room for a Third Dimension in Vocational Interest

Abstract

Discriminant function analyses involving two vocational interest inventories to differentiate majors of college graduates supported the definition of three dimensions: Business Contact vs. Science, Business Detail vs. Arts, and Service vs. Technical. This common structure between groups emerges only under rotation and is consistent with factor analytic results for differences among people. The implementation of such a three dimensional scheme for counseling high school students is illustrated. At the theoretical level these results support the position that the structure of vocational interests is more complicated than postulated by the circular orderings of Roe and Holland or by the appealing bipolar dimensions of Data/Ideas and People/Things.

Is There Room for a Third Dimension in Vocational Interest Differentiation?

Helping students and their counselors use vocational interest information in exploring educational and career choices has never before received so much attention from the psychometric community. An excellent example of a technique recently developed to facilitate such use is the discriminant function based "Map of College Majors" which is a part of the American College Testing (ACT) Assessment Program. The six scores from the ACT Interest Inventory (ACTII) are combined into two coordinates permitting students to plot their positions relative to those of the typical, satisfied college graduate in each of 24 educational majors. Such an impressive data base and comprehensible mode of presentation are so promising as to compel test makers to ask if the technique could be made even more meaningful.

Hanson (1974) has proposed an initial set of research questions:

> If different groups or a different interest inventory had been used, the two factors might have been quite different.... Could the discriminant factors be "rotated" to provide a more psychologically meaningful structure? Are there "basic" factors which best differentiate among a variety of different types of groups? Could such basic factors be identified using other interest inventories? (p. 52)

To these questions the present study added whether or not two is the

appropriate number of discriminant functions for the task.

ACT's choice of two dimensions for the Map is understandable in light of two considerations. First, the ACTII is consistent with Holland's circular or planar typology, one which postulates that inter-individual variability is satisfactorily explained by two factors or dimensions. If two dimensions explain differences among people, it follows that no more than two will explain differences among groups of people. Second, the technique of discriminant function (DF) analysis is such that it concentrates the bulk of intergroup variability in the first functions or dimensions making it likely that the first two will account for the majority of among group differences. (Note that the term "dimension" was used above after both "factors" and "functions" as a bridge between these very different terms; "dimension" here will thus refer to either.)

As to the first consideration, the interest factor literature does not provide a consensus that two factors are sufficient to account for interindividual variability--perhaps as many as eight factors are necessary. For example, within the frameworks of Holland and Roe, as measured by the Vocational Preference Inventory (VPI) and Vocational Interest Inventory (VII) respectively, four factors were recently identified--Social vs. Technical, Organizational vs. Outdoor, Science vs. Business Contact, and Artistic (Lunneborg and Lunneborg, 1975).

The second consideration in ACT's choice of two dimensions may be addressed within the context of rotating DF's. Hanson has suggested that

rotation of DF's may improve meaningfulness as it does in factor analysis. Rotation, however, has a second effect: It redistributes the total amount of variability accounted for by a set of DF's. Thus, a third significant DF, which when raw seems to contribute so little that it can be ignored, may make a more impressive contribution to group discrimination after rotation. As in factor analysis, the decision as to the number of DF's to retain is made prior to rotation. Rotation neither increases nor decreases this number, nor does it affect overall group discrimination.

The present study thus asked four questions: (1) Can the same DF results be obtained with a different interest inventory and a different sample as were obtained with the ACTII? (2) Is interpretability of DF's increased by rotation? (3) Are there basic dimensions separating groups consistent with the dimensions separating people; in particular, is there a correspondence between the factors identified in the above cited VPI-VII study and the DF's identified with the ACTII and VII? (4) Is interpretability and correspondence of results improved by looking at more than two DF's? The extent to "interpretability" is enhanced must necessarily be judged at two levels, that of the psychometrician searching for the basic structure to interests, and that of the high school student trying to make sense of such results for vocational decision making.

Method

Subjects

The VII sample consisted of 552 June 1975 graduates of the University of Washington who majored in the following eleven groups: Biological Sciences or BIO SCI (N = 66), Engineering or ENGR (N = 54),

Fisheries/Forestry or FISH/FOR (N = 30), Health Professions or HEALTH (N = 44), Humanities or HUM (N = 59), ARTS (N = 30), Political Science or POL SCI (N = 26), Physical Sciences or PHY SCI (N = 51), Business Administration or BUS ADM (N = 116), Communications or COMM (N = 37), and NURSING (N = 39). All had taken the VII as part of the Washington Pre-College (WPC) test battery in their high school junior year.

The ACT sample is that described by Hanson (1974, Table 23), a nation-wide group of 12,169 seniors of 1973 who majored in Accounting (ACCT), Agriculture (AGRI), ART, Art Education (ARTED), Biological Sciences (BSCI), Business (BUS), Business Education (BUSED), Economics (ECON), Elementary Education (ELED), Engineering (ENGR), English and Literature (ENGL), Foreign Languages (LANG), Health Fields (HEAL), History (HIST), Home Economics (HECON), Marketing (MKTG), Mathematics (MATH), Music Education (MUSED), Philosophy and Religion (PHIL), Physical Science (PHSCI), Political Science (POLSC), Psychology (PSYCH), Social Science (SSCI), and Sociology (SOC). The ACTII was taken by them as college seniors.

Instruments

The VII (Lunneborg, 1976) consists of 112 forced-choice items divided into sets of 56 items each, an Occupations section and an Activities section. Each VII scale consists of 28 items, 14 from each of these two sections. Each item in Occupations consists of two occupational titles which have been matched for Roe level and drawn from two different Roe groups. Each of the eight Roe groups is paired twice with each of the others to produce 56 items. Activities likewise pairs each of the eight groups twice with each of the others but here the content consists of

leisure time and avocational activities appropriate to a high school population. The VII is constructed to eliminate sex differences at the item level. Its ipsative scores are thus standardized against a mixed sex sample of 5,000 respondents.

The ACTII measures Holland's six RIASEC interest areas. Each of the six scales consists of 15 occupational activities which are rated on a 5-point Like-Dislike scale resulting in a mean rating score for each test. Scores are subsequently standardized separately for the sexes. The two "additions" to this circular ordering from Roe's similar schema result from the division of Creative arts into "General cultural" and "Arts & Entertainment," and from the division of Technical into "Technical" and "Outdoor."

Procedure

A discriminant function analysis was performed on the VII data and the largest DF's rotated to a varimax criterion of simple structure. This same rotational procedure, designed to improve counseling usefulness of DF's and fully described in Lunneborg and Lunneborg (in press), was also applied to the ACTII DF results from Tables 25 and 26 of Hanson (1974).

Results

The VII discriminant analysis yielded five significant functions accounting in turn for 41%, 30%, 13%, 7%, and 6% of between group variability. The first three of these DF's were utilized in the rotation and their 84% of between group variability compares with the 86% reported by Hanson, the first three DF's in the ACTII accounting in turn for 39%, 35%, and 12%. The correlations of the rotated DF's with the interest

scales are given in Table 1 for both inventories. The redistribution of between group variability is indicated in the "percent trace" entries. As expected, for both sets of DF's the contribution of DF 3, reflected in this percent trace, increased after rotation. To facilitate comparison of the rotated results for the two analyses, the order of ACTII rotated DF's 2 and 3 were interchanged in the left half of Table 1. A plot of the college major centroids in the rotated space is given for the VII in Figure 1 and for the ACTII in Figure 2. The decision to rotate only three DF's was based on the arbitrary judgment that the fourth and fifth contributed too little variance to be useful in counseling.

Insert Table 1 and Figures 1 and 2 about here

Discussion

From an examination of the left half of Table 1, it can be tentatively concluded that the answer to research question one is "yes": Effectively the same three dimensions were isolated from the two analyses. They were (1) Business Contact vs. Science, (2) Service vs. Technical, and (3) Business Detail vs. Arts. The second question also appears to be answered "yes": Because the rotated DF's are dependent upon fewer scales, they are more easily interpreted. For example, in Table 1 the second unrotated VII DF had correlations of .40 or higher with five of the eight scales, while rotated VII DF 2 was correlated .40 or higher only with SER and TEC.

In both analyses the Business Contact vs. Science rotated DF was the most powerful discriminator. The other two rotated functions, however, were

differentially discriminating in the two analyses. For the ACTII data the Business Detail vs. Arts DF was more important that Service vs. Technical in discriminating groups, while for the VII data Service vs. Technical was the second most important. What caused this? It is suggested that this difference in importance (percent trace) between the two analyses is more due to differences in the major groups studied than due to differences between the two tests.

The third research question concerned how these rotated DF's correspond to the four dimensions found in factor analysis. Do they have the same psychological interpretation? There would seem to be fairly close agreement. However, the Organizational vs. Outdoor factor and the Artistic factor of the VPI-VII study have combined here to produce a single dimension, Business Detail vs. Arts. Because of the consolidation of two dimensions into one, it is important in the counseling use of the third VII dimension to focus on an individual's score rather than upon the closest major group. Is the client more in the direction of indoor, organizational interest, or more in the direction of either outdoor or artistic interest? Notice how the bipolarity of this dimension would help a student who on the first two DF's was close to both FISH/FOR and ENGR, or close to both NURSING and ARTS.

Finally, the fourth question concerning the number of DF's necessary for easy interpretability and correspondence of results must also be answered positively. The congruence of the results depicted in Table 1 and in the figures depended on two things. First, the DF's had to be rotated. A comparison of correlations between unrotated DF's and the

scales of the two tests (right half, Table 1) suggests little correspondence. Second, three not two DF's were required. If only two had been rotated, then a service-related dimension would have been lost on the ACT side, while on the VII side the organizational contribution would have been missing. To see the consistency across these two inventories required considering more than the two largest DF's.

It is noteworthy that this consistency was achieved despite several differences in the instruments: Giving the VII characteristics first these include: (1) basis of classification, Roe vs. Holland, (2) scale properties, ipsative vs. normative, (3) item content, occupational titles and avocational activities vs. occupational activities, (4) treatment of sex differences, item selection vs. separate sex norms, (5) time of testing, predictive (in high school) vs. concurrent (as college seniors), and (6) sampling variation, one university vs. national sample.

There is, however, still the issue of how effectively three rotated DF's can be interpreted by individual counselors and their clients. Figure 1 illustrates one approach to using a third DF in counseling. This style of data presentation, a "Dimension Diagram" with its three associated "Dimension Locators" (DF's), was initiated autumn 1976 by the WPC program. In the WPC Student Guide (1976) students plot their Dimension Locators and compare the results of their normative profile of interests with the college major groups they were located nearby. Throughout the supporting interpretive material students are urged to develop an appreciation of the underlying meanings to the three dimensions rather than to focus on the specific groups they are nearest to. How useful Figure 1 will actually be

in counseling is currently being evaluated.

Figure 2 illustrates how the third dimension in the ACTII could similarly be presented. To facilitate comparison between the two inventories, the second and third DF's to the ACTII have been interchanged in the figure. In actual practice, it is better to base a two-dimensional plot on the two most powerful, rotated dimensions, which for ACTII means Business Contact vs. Science and Business Detail vs Arts.

Finally, the results of this study need to be discussed in light of a theoretical position taken in the development of the ACTII (see Hanson Appendix I, 1974). ACT has gone to considerable effort to relate their interest test to the two-dimensional theoretical orientation of the Data/Ideas and People/Things framework, one which they feel appropriately reflects the accumulated research evidence on the basic dimensions underlying work. Especially reinforcing to this theoretical position are the directed rotations of ACTII factor analyses, the results of which (Hanson's Table 30, p. 64, 1974) produced the desired patterns of correlations: with the Data/Ideas Factor, Science and Creative Arts had negative correlations, while Business Contact and Business Detail had positive correlations; with the People/Things Factor, Technical had a negative correlation and Social Service had a positive correlation.

It is agreed that if there are only two dimensions underlying work, then this framework is probably the most useful one. However, the two theoretically-targeted factors in the above analyses accounted for less then 60% of the variance, leaving an appreciable amount unexplained. The

question is, can any of this unexplained variance be given consistent, psychological interpretation? If it can, then it may be premature to opt for a two-dimensional theory. Taking the VPI-VII study's results and the present results together, there is evidence that there are from three to five important and interpretable factors inherent in the Roe-Holland interest groups. And only one of these, Service vs. Technical, corresponds to ACT's theoretical structure, i.e., to People vs. Things. Thus, in continuing developmental work with the VII emphasis will be given to establishing an appropriate number of factors before any theoretical structure is imposed on those dimensions.

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Table 1

Comparison of First Three Rotated and Unrotated Discriminant Functions from ACT Interest Inventory and the Vocational Interest Inventory

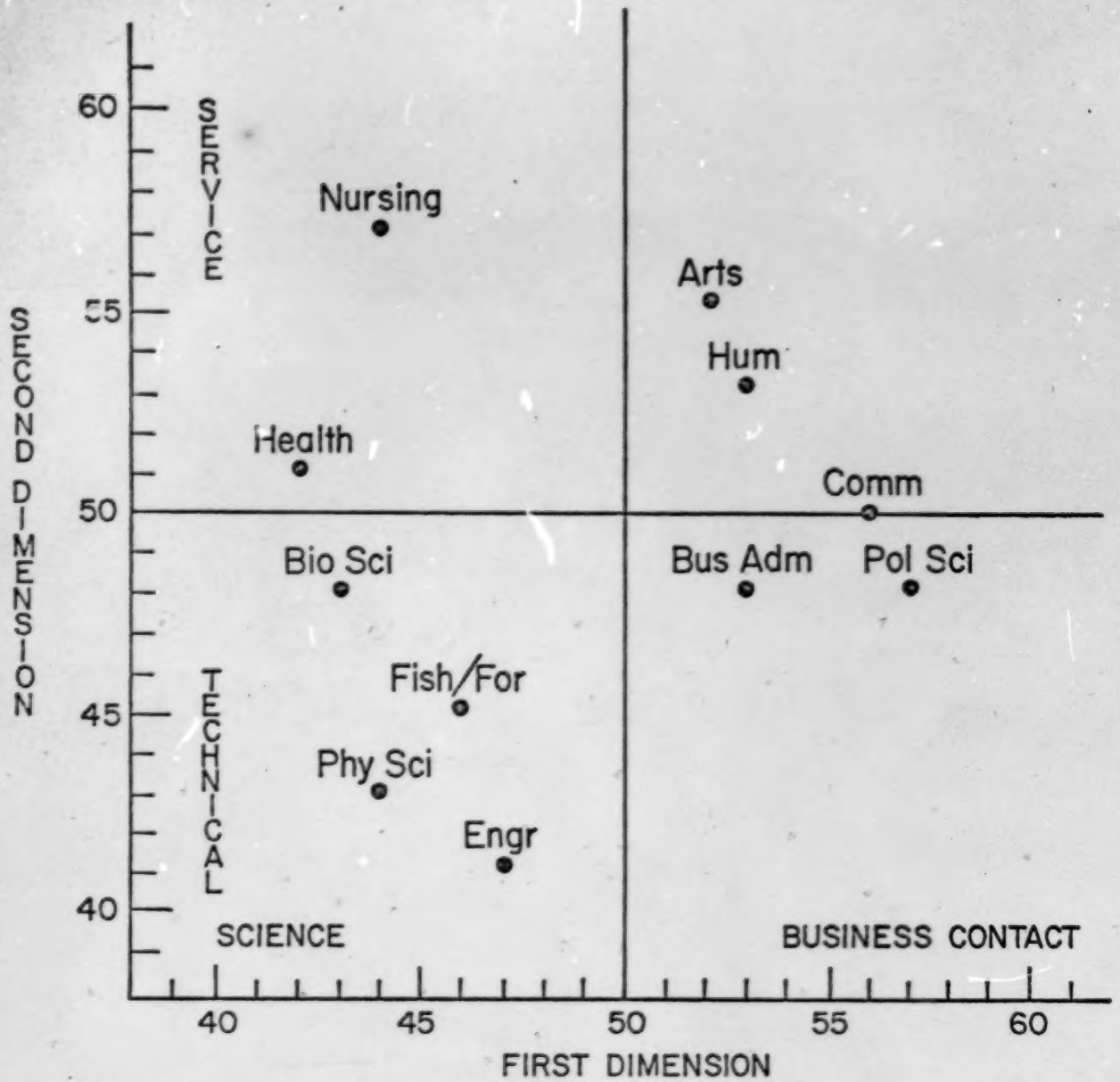
	Correlation with rotated functions			Correlation with unrotated functions		
ACT scales	1	3	2	1	2	3
Science	-81	-12	10	-72	39	-05
Creative arts	15	01	-72	-05	-64	-35
Social service	05	88	-07	-11	-49	73
Business contact	59	02	20	61	-03	12
Business detail	33	-15	72	53	56	23
Technical	-28	-27	05	-20	26	-21
Percent trace	38	18	30	39	35	12
VII scales	1	2	3	1	2	3
Science	-88	-19	-15	-76	51	04
General cultural	50	08	00	43	-25	06
Arts & entertainment	21	28	-47	44	32	22
Service	-07	80	13	37	38	-62
Business contact	57	-12	28	31	-57	00
Organization	26	03	73	03	-59	-50
Technical	-22	-78	20	-67	-40	30
Outdoor	-24	-08	-66	-06	51	04
Percent trace	36	27	21	41	30	13

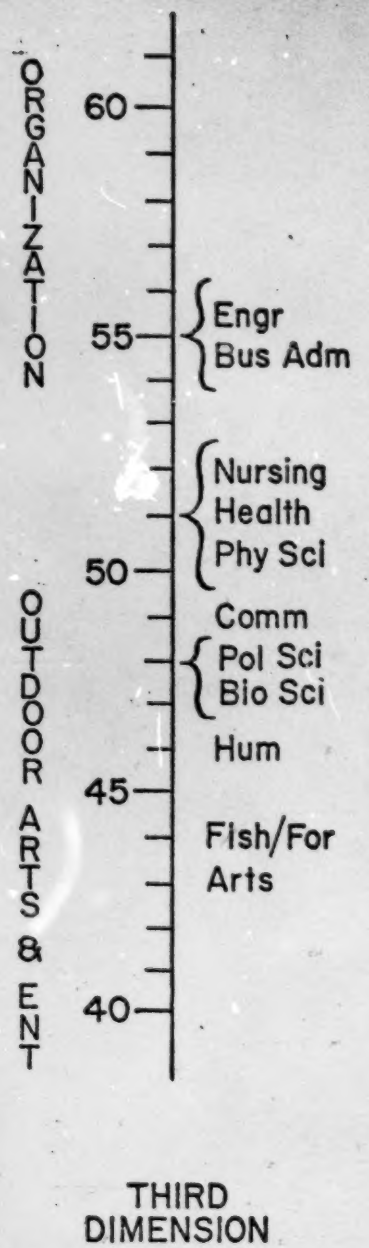
Note.--Decimal points omitted. Entries of |.40| and greater underlined.

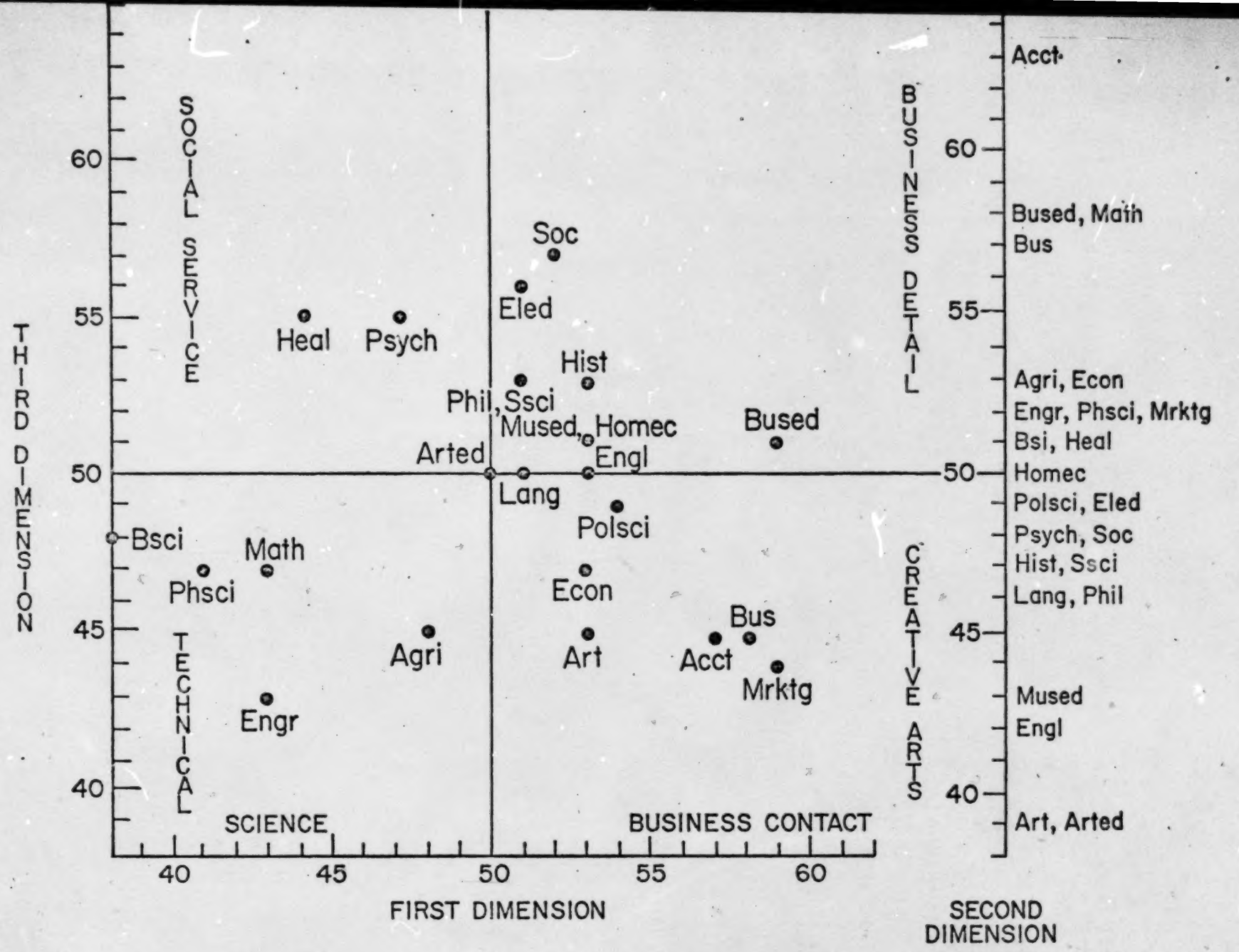
Figure Captions

Figure 1. College major centroid locations based on three rotated discriminant functions from Vocational Interest Inventory scales.

Figure 2. College major centroid locations based on three rotated discriminant functions from ACT Interest Inventory scales.


SECOND DIMENSION
60
55
50
45
40
SERVICE
TECHNICAL
SCIENCE
BUSINESS CONTACT
Nursing
Arts
Hum
Health
Comm
Bio Sci
Bus Adm
Pol Sci
Fish/For
Phy Sci
Engr
40
45
50
55
60
FIRST DIMENSION


ORGANIZATION
OUTDOOR ARTS & ENT
60
55
50
45
40
Engr
Bus Adm
Nursing
Health
Phy Sci
Comm
Pol Sci
Bio Sci
Hum
Fish/For
Arts
THIRD DIMENSION


THIRD DIMENSION
SOCIAL SERVICE
TECHNICAL
SCIENCE
BUSINESS CONTACT
BUSINESS DETAIL
CREATIVE ARTS
FIRST DIMENSION
SECOND DIMENSION
60
55
50
45
40
Heal
Psych
Soc
Eled
Hist
Phil, Ssci
Mused, Homec
Arted
Engl
Lang
Bsci
Math
Phsci
Polsci
Econ
Agri
Art
Bus
Acct
Mrktg
Engr
Busied
Acct
Busied, Math
Bus
Agri, Econ
Engr, Phsci, Mrktg
Bsi, Heal
Homec
Polsci, Eled
Psych, Soc
Hist, Ssci
Lang, Phil
Mused
Engl
Art, Arted